

# PATENT ABSTRACTS OF JAPAN

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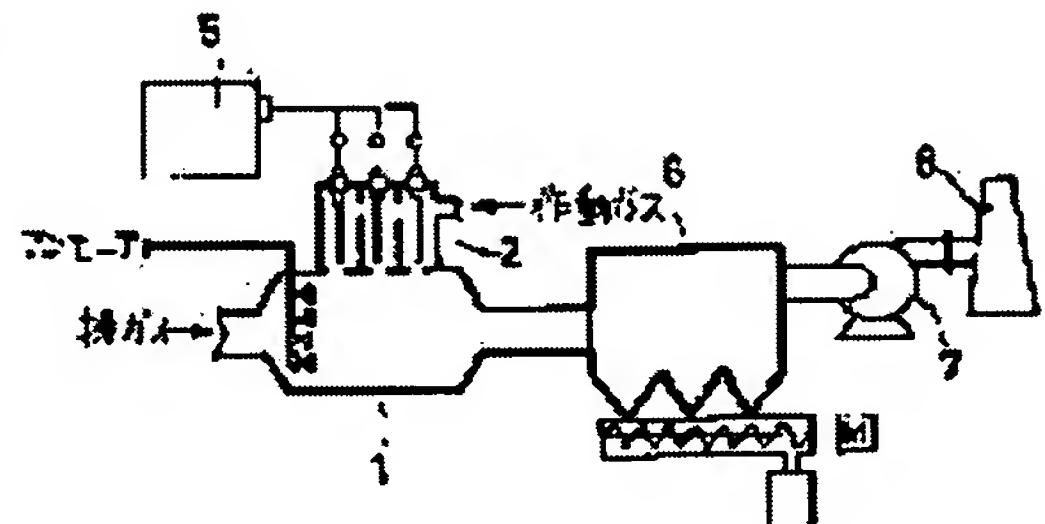
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SASAKI KUNIO

## (54) TREATMENT OF WASTE GAS BY STEAM PLASMA

### (57)Abstract:

**PURPOSE:** To efficiently treat a waste gas without using the electron beam irradiation device by supplying the single substance of steam or the gaseous mixture of the steam and a diluent gas to the plasma generating device as the operating gas of the plasma and oxidizing the harmful component in the waste gas to make harmless.



**CONSTITUTION:** The single substance of steam or the gaseous mixture of the steam and the diluent gas is supplied to the plasma generating device 2 as the operating gas of the plasma, and a generated gaseous steam plasma is supplied into the waste gas, and the harmful component in the waste gas is oxidized by the plasma to make harmless. At that time, ammonia or urea is supplied into the waste gas to solidify the oxidation products of NOx and/or SOx in the waste gas as ammonium salts. In such a way, the active chemical speed such as OH, O, H, HO<sub>2</sub> is generated without using the electron beam irradiation device, and waste gas can be treated using the device.

### LEGAL STATUS

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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The offgas treatment approach by the steam plasma which supplies the mixed gas of a steam simple substance or a steam, and dilution gas to a plasma generator as working medium of the plasma, supplies the steam plasma gas which occurred into exhaust gas, and is characterized by oxidizing and defanging the injurious ingredient in exhaust gas by the plasma.

[Claim 2] How to supply ammonia or a urea to exhaust gas, and solidify NOx in exhaust gas, and/or the oxidation product of SOx as ammonium salt in an approach according to claim 1.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Industrial Application] This invention relates to the offgas treatment approach by the steam plasma more at a detail about the approach of carrying out oxidation removal of the harmful organic compounds, such as NOx, SOx and CO which are contained in combustion gases, such as a boiler, a heating furnace, and an incinerator, or dioxin.

#### [0002]

[Description of the Prior Art] The approach shown in drawing 3 is proposed as an approach of oxidizing the nitrogen oxides (NOx) in exhaust gas, a sulfur oxide (SOx), a carbon monoxide (CO), a minute amount organic compound, etc. to coincidence. Namely, this approach is set in the reaction zone (21) established in the gas passageway. The electron beam generated with the electron accelerator (22) is irradiated at exhaust gas. Chemical species [ activity / in exhaust gas ], OH, O, H, and HO2 etc. -- after generating and oxidizing NOx, SOx and CO in exhaust gas, an organic compound, etc. to coincidence by these activity chemical species, ammonia is added to exhaust gas and it is called recovery \*\*\* in solid form by using the oxidation product of NOx and SOx as ammonium salt. In addition, as for an electric shielding wall and (24), (23) is [ a dust collector and (25) ] suction blowers among drawing 3 .

#### [0003]

[Problem(s) to be Solved by the Invention] In an above-mentioned conventional method, since an electron beam is irradiated at exhaust gas, it is necessary to form the electron ray accelerator which is expensive and large-sized equipment and, and it is necessary to establish the electric shielding wall which encloses this and prevents scattering of an electron ray, and an installation cost costs dearly, in addition there is severe constraint on ionizing-radiation handling, and there is also a difficulty from the field on handling. This approach has still come [ therefore, ] to be put in practical use.

[0004] the \*\* which does not use electron-beam-irradiation equipment in order that the purpose of this invention may conquer the above-mentioned fault -- efficient -- OH, O, H, and HO2 etc. -- activity chemical species are made to generate and it is in offering the approach of processing exhaust gas using this.

#### [0005]

[Means for Solving the Problem] The offgas treatment approach by this invention is devised that the above-mentioned purpose should be attained, supplies the mixed gas of a steam simple substance or a steam, and dilution gas to a plasma generator as working medium of the plasma, supplies the steam plasma gas which occurred into exhaust gas, and is characterized by oxidizing and defanging the injurious ingredient in exhaust gas by the plasma.

[0006] In the above-mentioned approach, preferably, ammonia or a urea is supplied to exhaust gas, and NOx in exhaust gas and/or the oxidation product of SOx are solidified as ammonium salt.

[0007] As dilution gas, one sort or several sorts of mixed gas of air, nitrogen, oxygen, carbon dioxide gas, and the argons is used preferably.

#### [0008]

[Function] The mixed gas of a steam simple substance or a steam, and dilution gas is supplied to a plasma generator, and it is [Formula 1].

## 放電



## 放電

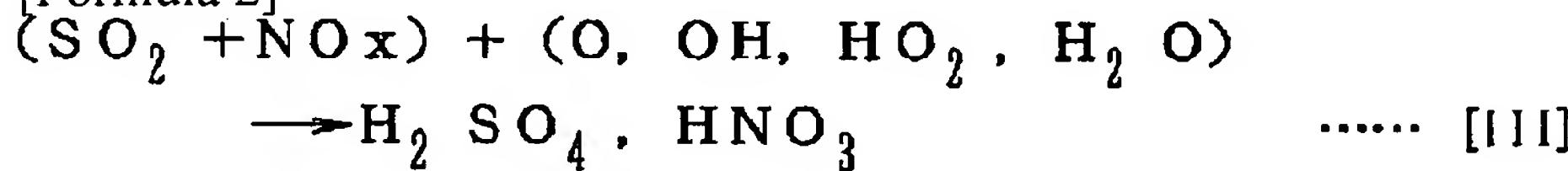


the becoming reaction -- plasma-izing of a steam and oxygen -- activity chemical species, O, OH, H and HO<sub>2</sub>, and O<sub>3</sub> etc. -- it is made to generate

[0009] These activity chemical species, O, OH, H and HO<sub>2</sub>, and O<sub>3</sub> NO<sub>x</sub> and SO<sub>2</sub> in exhaust gas Like the following formula, it reacts and a corresponding oxide is generated.

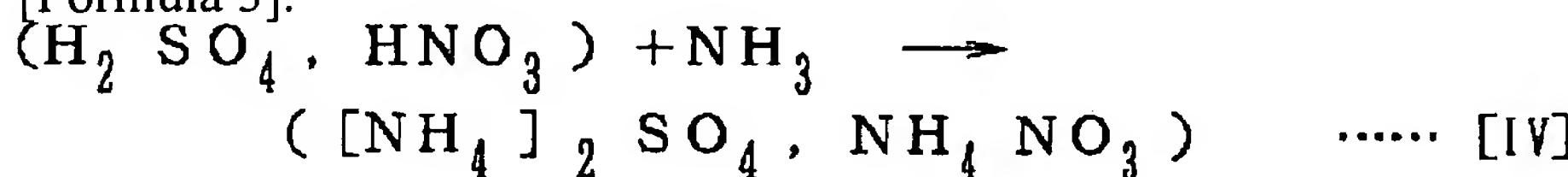
[0010]

[Formula 2]



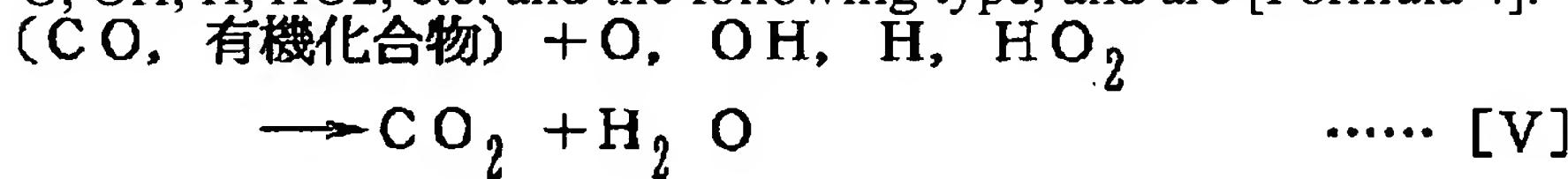
Like the following type, the sulfuric acid and nitric acid which were produced at the above-mentioned reaction when ammonia was supplied to exhaust gas react with ammonia, and are

[Formula 3].



It solidifies as corresponding ammonium salt. This solid-state is removed from exhaust gas by the dust collector of back wash.

[0011] Moreover, CO and the organic compound in exhaust gas react like activity chemical species, O, OH, H, HO<sub>2</sub>, etc. and the following type, and are [Formula 4].



It is defanged.

[0012]

[Example] An example explains the offgas treatment approach by this invention concretely.

[0013] Reaction zone established in the gas passageway in drawing 1 (1) It is a plasma generator (2) to the top section. It installs. Plasma generator (2) As shown in drawing 2, it is a positive electrode (3). Negative electrode (4) It has and is a negative electrode (4). Direct-current high voltage power supply (5) It has the connected structure.

[0014] Plasma generator (2) The mixed gas of a steam simple substance or a steam, and dilution gas is supplied as working medium of the plasma. As dilution gas, one sort or several sorts of mixed gas of air, nitrogen, oxygen, carbon dioxide gas, and the argons is used, and it is a plasma generator (2). It supplies.

[0015] It is a reaction zone (1) about the steam plasma gas which occurred by the above-mentioned formula [I] or [II]. It sets, exhaust gas is supplied and the injurious ingredient in exhaust gas is oxidized by the plasma (refer to above-mentioned formula [III] and [V]).

[0016] Moreover, reaction zone (1) Ammonia gas is poured in and it is the above-mentioned reaction. It solidifies as ammonium salt which corresponds the sulfuric acid and nitric acid which were produced in [III] by the reaction of a formula [IV]. This solid-state is the dust collector (6) of back wash. It is removed from exhaust gas.

[0017] In addition, the inside of drawing 1 and (7) A suction blower and (8) It is a chimney stack.

[0018]

[Effect of the Invention] the activity chemical species conventionally acquired only by electron beam

irradiation by the offgas treatment approach of this invention since the mixed gas of a steam simple substance or a steam, and dilution gas was plasma-ized, O, OH, H and HO<sub>2</sub>, and O<sub>3</sub> etc. -- it can obtain easily and all the problems of the constraint on installation of the electron ray accelerator which was the biggest problem of an electron-beam-irradiation method, and ionizing-radiation handling can be solved. In this way, by the approach of this invention, coincidence multiple-purpose offgas treatment is possible.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] It is the flow sheet which shows the offgas treatment approach by this invention.

[Drawing 2] It is the sectional view showing a plasma generator.

[Drawing 3] It is the flow sheet which shows a conventional method.

[Description of Notations]

- 1: Reaction zone
- 2: Plasma generator
- 3: Positive electrode
- 4: Negative electrode
- 5: Direct-current high voltage power supply

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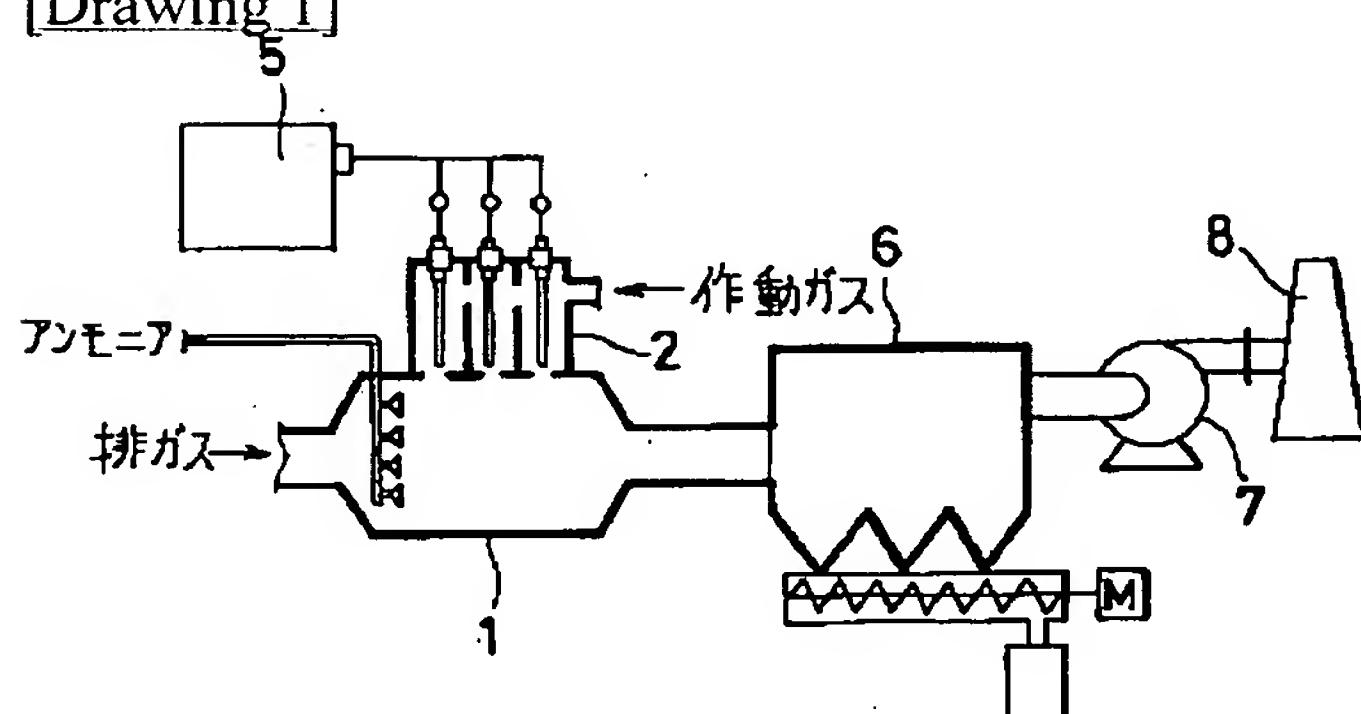
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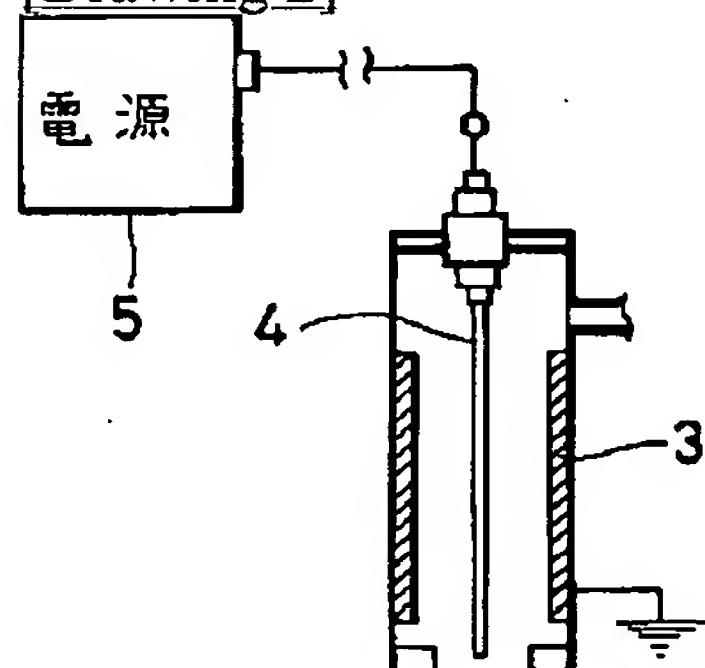
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## DRAWINGS

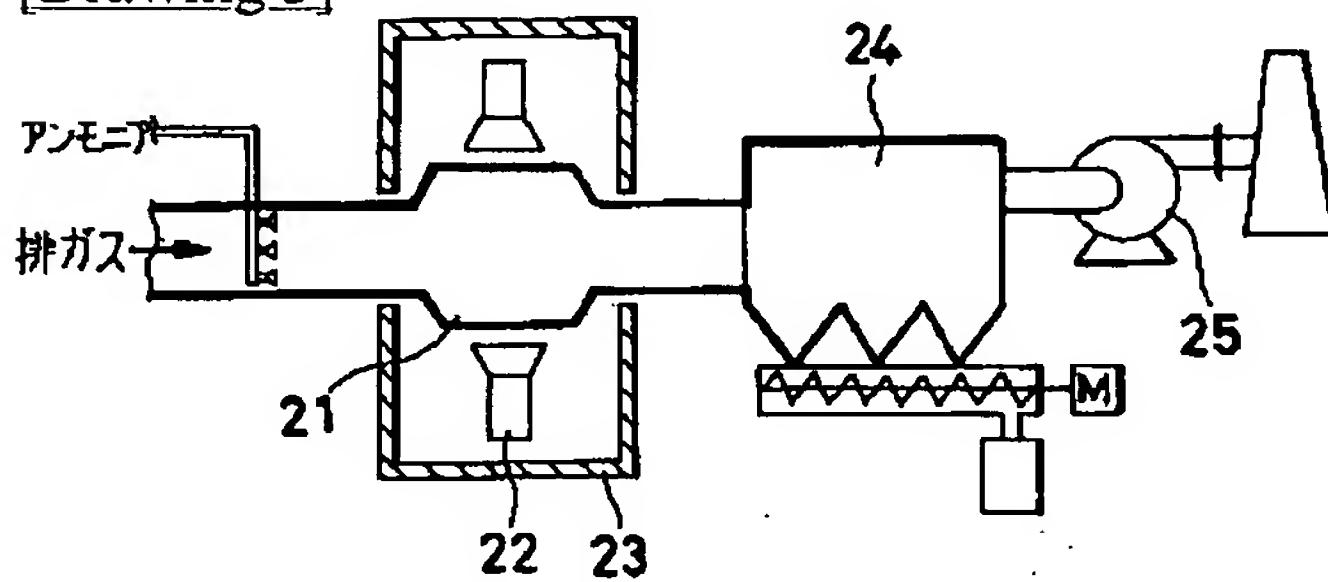
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]

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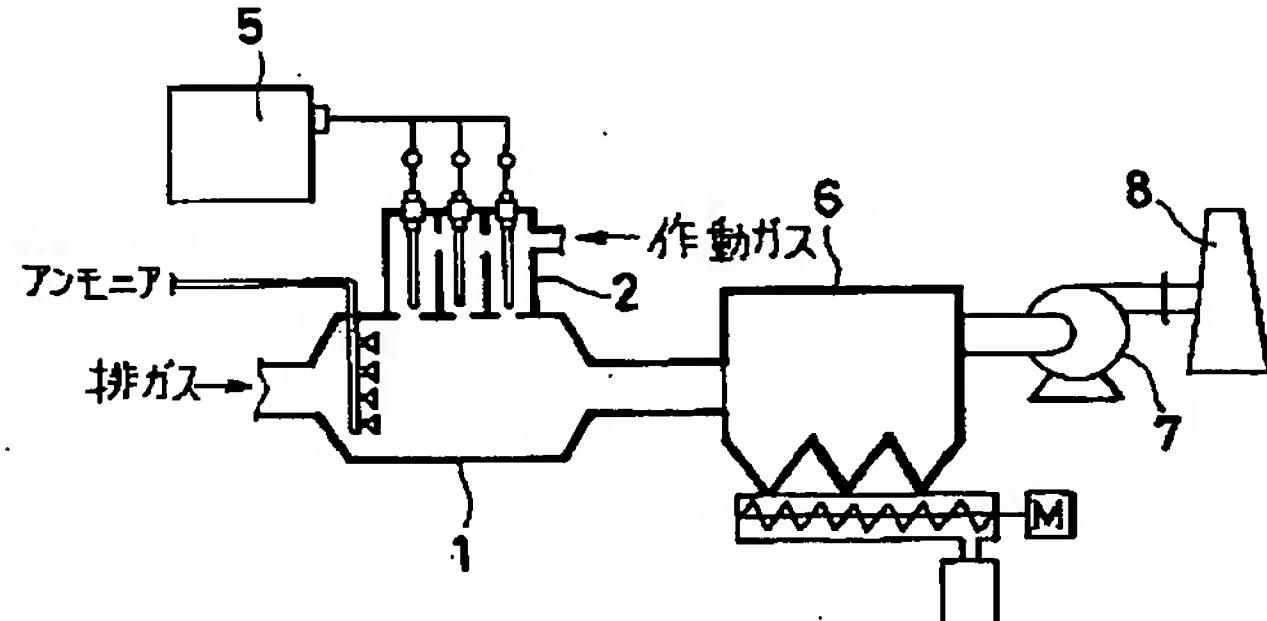
(74)代理人 弁理士 岸本 瑛之助 (外3名)

(54)【発明の名称】 水蒸気プラズマによる排ガス処理方法

(57)【要約】

【構成】 水蒸気単体あるいは水蒸気と希釈ガスとの混合ガスをプラズマの作動ガスとしてプラズマ発生装置に供給し、発生した水蒸気プラズマガスを排ガス中に供給し、排ガス中の有害成分をプラズマによって酸化し無害化することを特徴とする、水蒸気プラズマによる排ガス処理方法である。

【効果】 従来は電子線照射でしか得られなかった活性な化学種、O、OH、H、HO<sub>2</sub>、O<sub>3</sub>などをプラズマ発生装置によって容易に得ることができ、電子線照射法の最大の問題であった電子線加速器の設置および電離放射線取扱上の制約といった問題をすべて解決することができる。こうしてこの発明の方法により、同時多目的排ガス処理が可能である。



## \*【0003】

【発明が解決しようとする課題】上述の従来法では、排ガスに電子ビームを照射するために高価で大型の装置である電子線加速器を設ける必要があり、またこれを囲って電子線の飛散を防止する遮蔽壁を設ける必要があつて、設備費が高くつき、加えて、電離放射線取扱上の厳しい制約があり、取扱上の面からの難点もある。そのため、この方法は未だ実用化されるに至っていない。

【0004】この発明の目的は、上記の欠点を克服するために電子線照射装置を使用せずに効率的にOH、O、H、HO<sub>2</sub>などの活性な化学種を生成させ、これを用いて排ガスを処理する方法を提供することにある。

## 【0005】

【課題を解決するための手段】この発明による排ガス処理方法は、上記目的を達成すべく工夫されたものであつて、水蒸気単体あるいは水蒸気と希釈ガスとの混合ガスをプラズマの作動ガスとしてプラズマ発生装置に供給し、発生した水蒸気プラズマガスを排ガス中に供給し、排ガス中の有害成分をプラズマによって酸化し無害化することを特徴とするものである。

【0006】上記方法において、好ましくは、排ガスにアンモニアまたは尿素を供給し、排ガス中のNO<sub>x</sub>および/またはSO<sub>x</sub>の酸化生成物をアンモニウム塩として固体化する。

【0007】希釈ガスとしては、空気、窒素、酸素、炭酸ガス、アルゴンのうちの1種または数種の混合ガスが好ましく使用される。

## 【0008】

【作用】水蒸気単体あるいは水蒸気と希釈ガスとの混合ガスをプラズマ発生装置に供給し、

## 【化1】

\*

## 放電



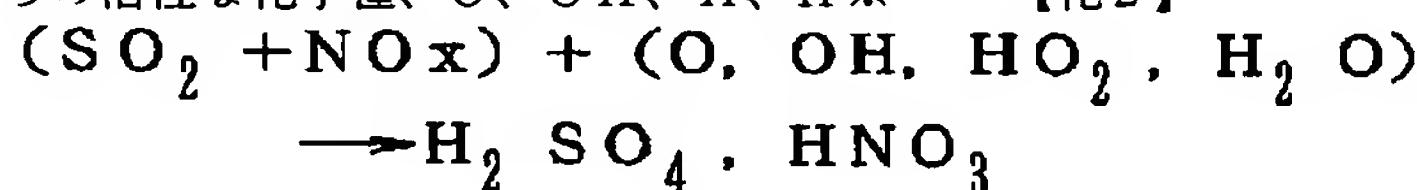
..... [I]

## 放電



なる反応で水蒸気および酸素のプラズマ化により活性な化学種、O、OH、H、HO<sub>2</sub>、O<sub>3</sub>などを発生させる。

【0009】これらの活性な化学種、O、OH、H、H※



..... [III]

40※O<sub>2</sub>、O<sub>3</sub>は、排ガス中のNO<sub>x</sub>およびSO<sub>2</sub>と下記式の如く反応し、対応する酸化物を生成する。

## 【0010】

## 【化2】

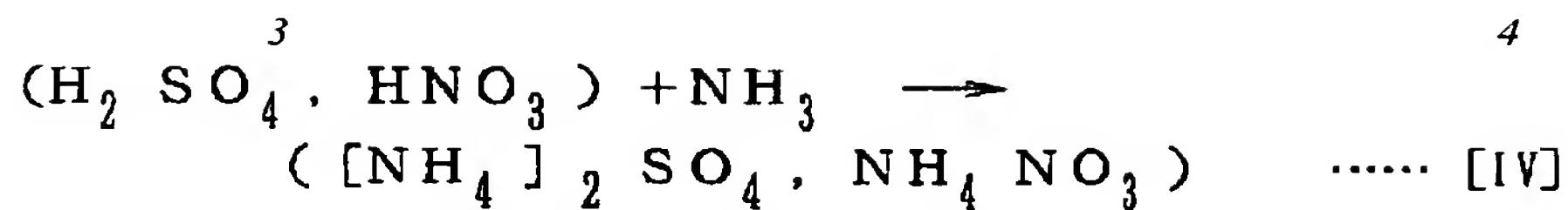


..... [III]

し、

## 【化3】

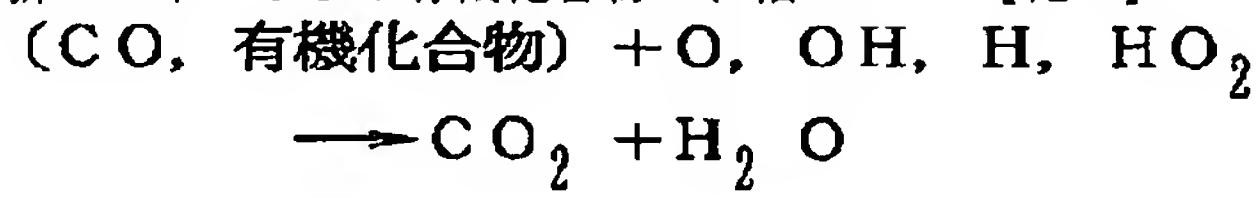
排ガスにアンモニアを供給する場合には、上記反応で生じた硫酸および硝酸は下記式の如くアンモニアと反応



4

対応するアンモニウム塩として固体化される。この固体は後流の集塵器で排ガスから除去される。

【0011】また、排ガス中のCOや有機化合物は、活性な化学種、O、OH、H、HO<sub>2</sub>などと下記式の如く反応し、



【化4】

..... [V]

無害化される。

【0012】

【実施例】この発明による排ガス処理方法を実施例により具体的に説明する。

【0013】図1において、ガス流路に設けられた反応ゾーン(1)の上側部にプラズマ発生装置(2)を設置する。プラズマ発生装置(2)は、図2に示すように、正極(3)と負極(4)を備え、負極(4)に直流高圧電源(5)が接続された構造を有する。

【0014】プラズマ発生装置(2)に水蒸気単体あるいは水蒸気と希釈ガスとの混合ガスをプラズマの作動ガスとして供給する。希釈ガスとしては、空気、窒素、酸素、炭酸ガス、アルゴンのうちの1種または数種の混合ガスを使用し、プラズマ発生装置(2)に供給する。

【0015】上記式[I]あるいは[II]によって発生した水蒸気プラズマガスを反応ゾーン(1)において排ガスに供給し、排ガス中の有害成分をプラズマによって酸化する(上記式[III]および[V]参照)。

【0016】また、反応ゾーン(1)にアンモニアガスを注入し、上記反応[III]で生じた硫酸および硝酸を式[IV]の反応により対応するアンモニウム塩として固体化される。この固体は後流の集塵器(6)で排ガスから除去される。

\*活性な化学種、O、OH、H、HO<sub>2</sub>などと下記式の如く反応し、

【化4】

..... [V]

【0017】なお、図1中、(7)は吸引プロワ、(8)は煙突である。

【0018】

【発明の効果】この発明の排ガス処理方法では、水蒸気単体あるいは水蒸気と希釈ガスとの混合ガスをプラズマ化するので、従来は電子線照射でしか得られなかった活性な化学種、O、OH、H、HO<sub>2</sub>、O<sub>3</sub>などを容易に得ることができ、電子線照射法の最大の問題であった電子線加速器の設置および電離放射線取扱上の制約といった問題をすべて解決することができる。こうしてこの発明の方法により、同時多目的排ガス処理が可能である。

【図面の簡単な説明】

【図1】この発明による排ガス処理方法を示すフローシートである。

【図2】プラズマ発生装置を示す断面図である。

【図3】従来法を示すフローシートである。

【符号の説明】

1：反応ゾーン

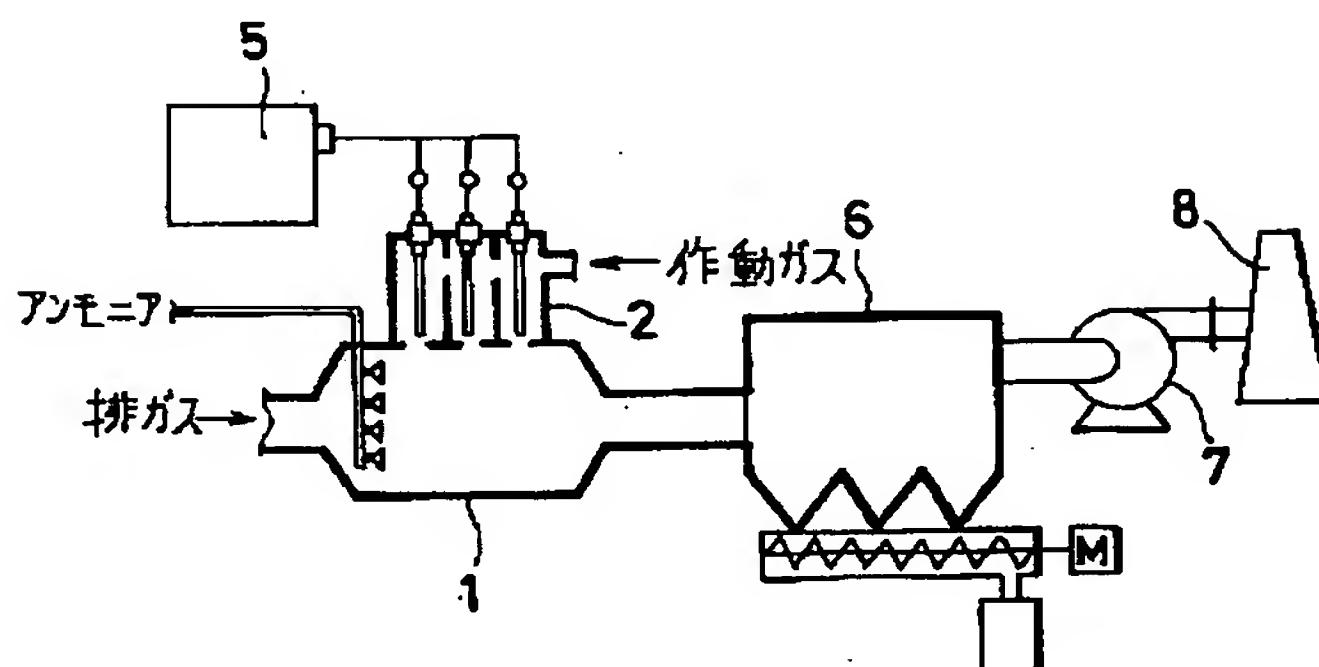
30 2：プラズマ発生装置

3：正極

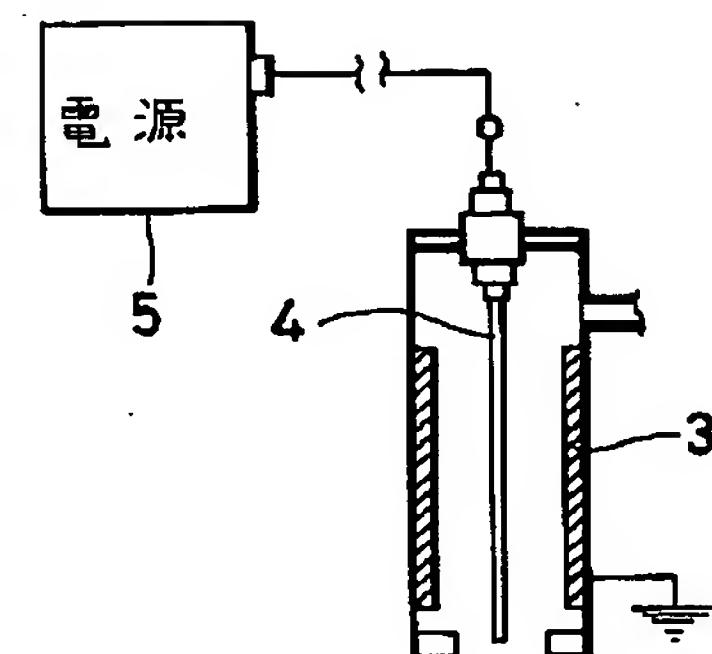
4：負極

5：直流高圧電源

【図1】



【図2】



【図3】

